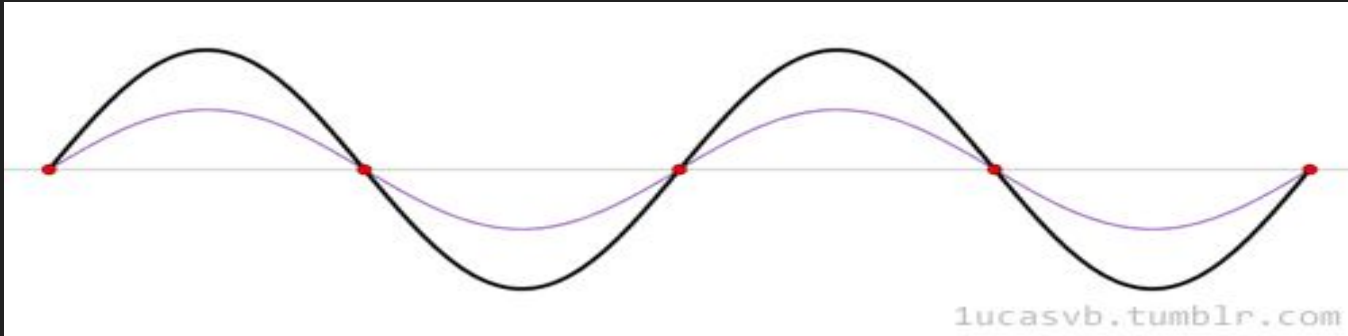# Waves

By: Andrew Aghadjanians, Ryan Crispi, Ben Donoho, Alex Juse, Grayson Kruizinga, and Nick Ortiz

What is a wave?

Wave: a wiggle in time and space

- produced by a vibration
- carries energy, does not transfer matter

1ucasvb.tumblr.com

Qualities & Parts of a Wave

Period (T)

- time required to for one back and forth cycle (measured in seconds)

Wavelength (λ)

- distance between identical parts of a wave (measured in meters)

Frequency (f)

- number of vibrations passing a point in a certain time (measured in hertz)
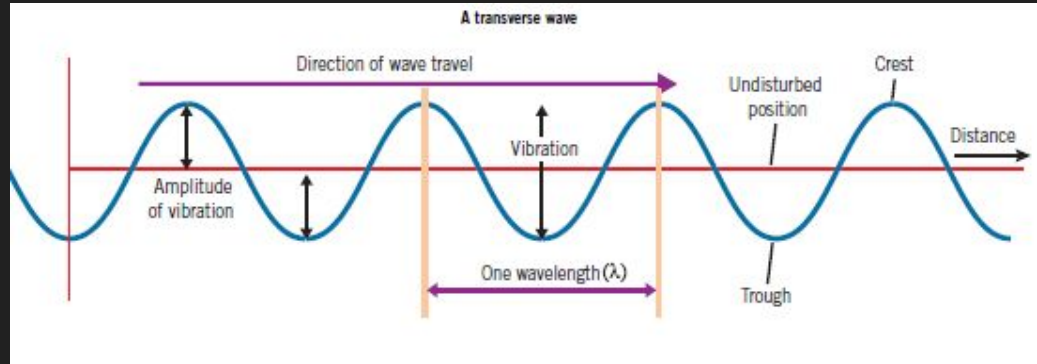
Qualities & Parts of a Wave (continued)

Velocity

- speed and direction of a wave (measured in meters per second)

Crests - highest point on a wave

Troughs - lowest point on a wave

Amplitude (A)

- distance from midpoint to crest or trough

Two Types of Waves

- **Transverse Wave**
  - The motion of the substance that is perpendicular to the direction that the wave travels
  - Ex: Ripples in water, a whip in motion, Light, and Earthquake secondary waves.
- **Longitudinal Wave**
  - The motion of the substance is the same direction that the wave travels.
  - Also known as Compression Wave
  - Ex: Earthquake primary waves, and Sound.


Transverse Wave

Longitudinal Wave

Interference

- The product of multiple waves meeting
- These waves meeting can overlap causing the creation of inference patterns, which can cause a change in specific qualities of the waves themselves
  - **Constructive interference**: When they overlap perfectly (crest to crest,) the magnitude is increased
  - **Destructive interference**: If not, (crest to troph) it decreases the effects of the wave

Constructive interference   Destructive interference

www.explainthatstuff.com
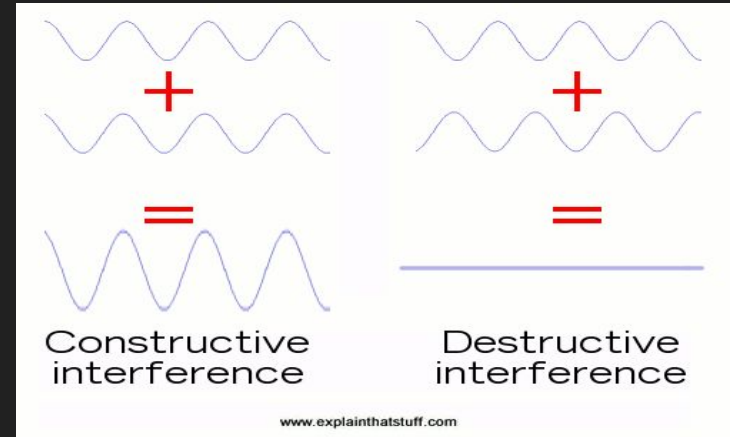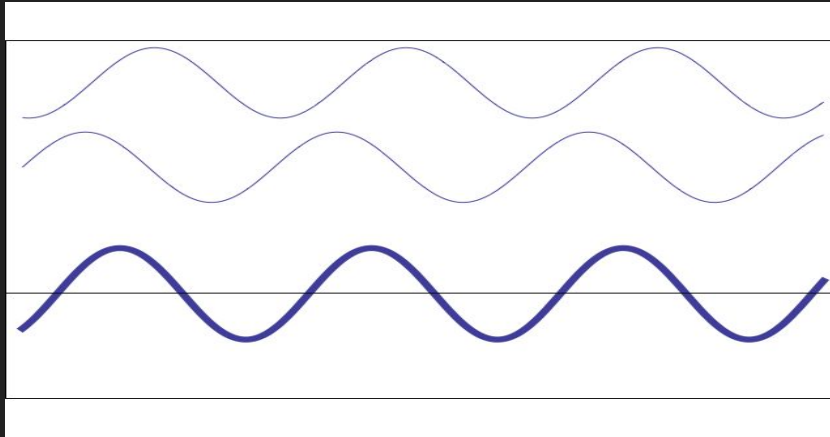
Standing Waves

- Standing waves, or stationary waves, are a kind of wave that has fixed points on certain parts of the wavelength
- These kinds of waves occur at specific frequencies
  - Think back to Mr. Fulmer's slinky lab
- The fixed points are commonly known as **nodes** and the points with the largest amplitudes on the wave are known as **antinodes**
  - Antinodes are not fixed and lie on the midpoints between two nodes
- Typically being created by interference, these waves are the result of two overlapping waves traveling in opposing directions
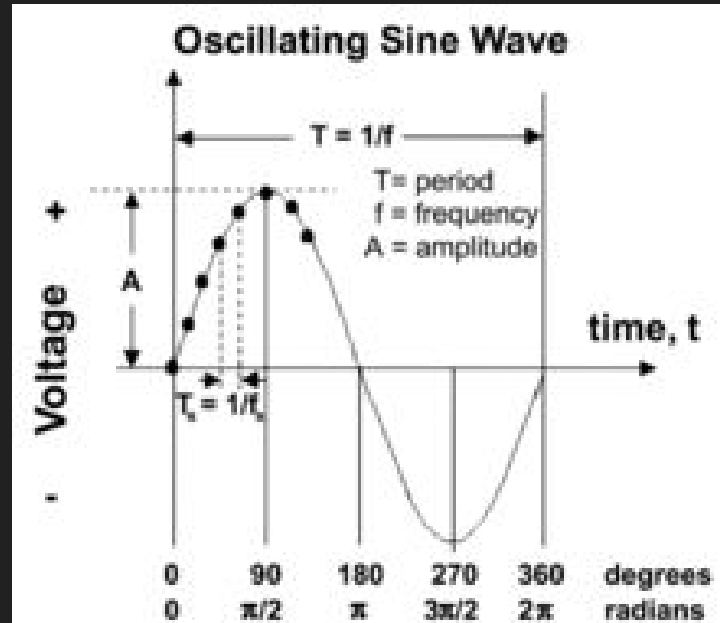 - The nodes are out of phase results of destructive interference

Standing Waves
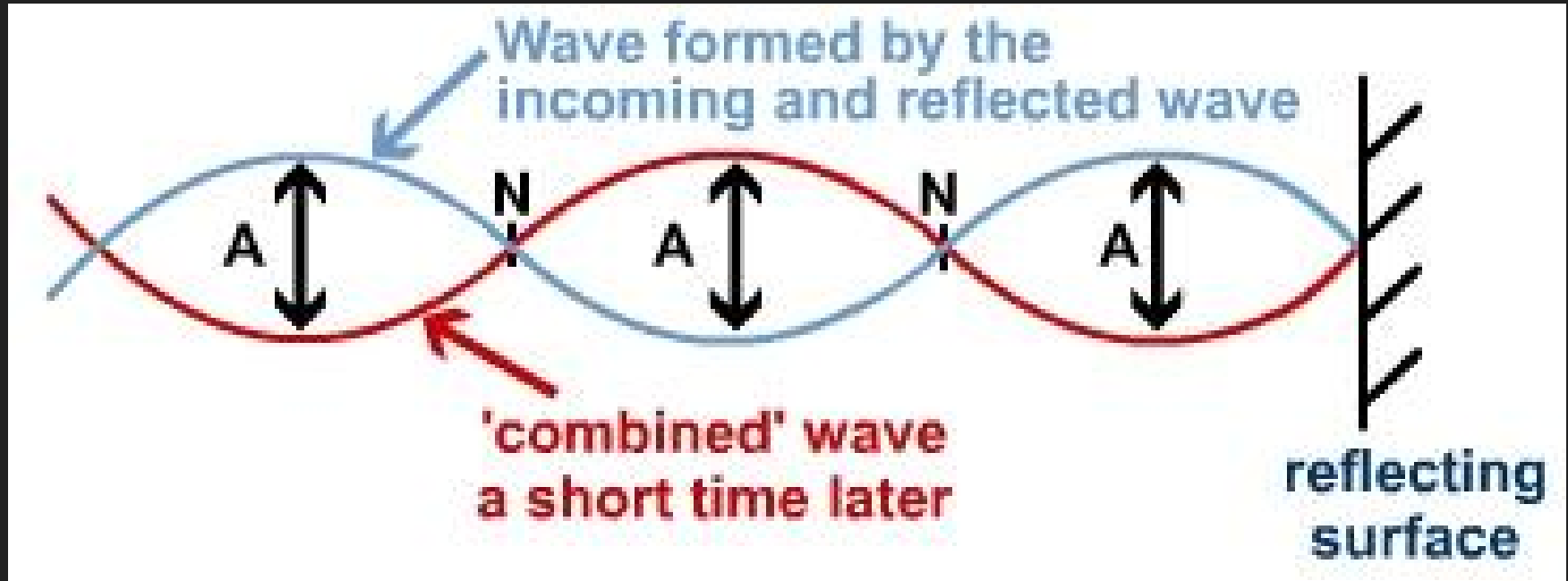
Phase

- The relationship between the period of a wave and an external reference point
- Two waves that are in phase are in synch
- Two waves that are out of phase are out of synch

Interferometry

- A family of techniques using wave interference patterns to extract information about the wave
- Is mainly used to measure interference between light waves
- This method led to the discovery of gravitational waves
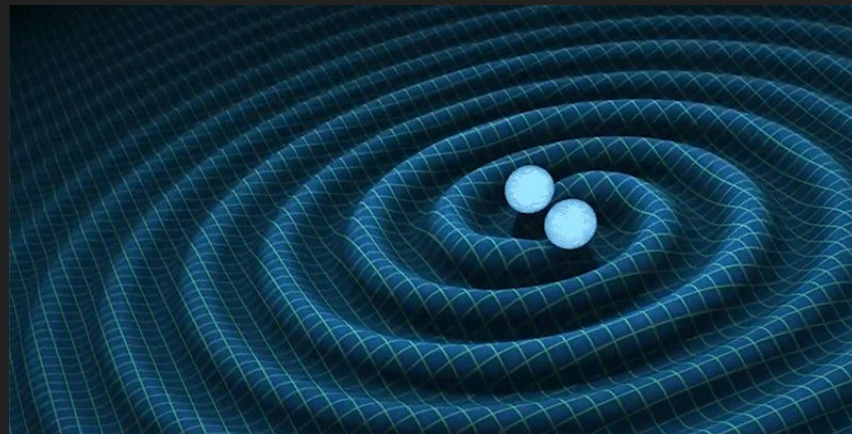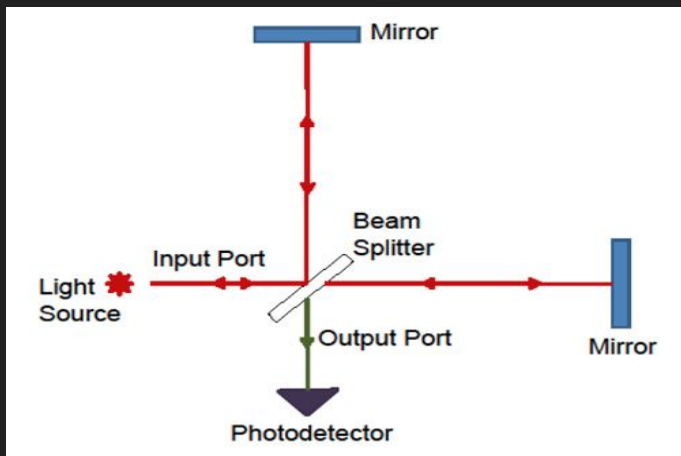
How do Interferometers work?

- A laser beam travels through a beam splitter which splits it into two different beams
- One beam passes straight through while the other is reflected at 90 degrees.
- Mirrors reflect each beam back to the beam splitter in which the two beams of light merge into one.
- The beams interfere with one another as they go through a photodetector, which measures the brightness of the beam.
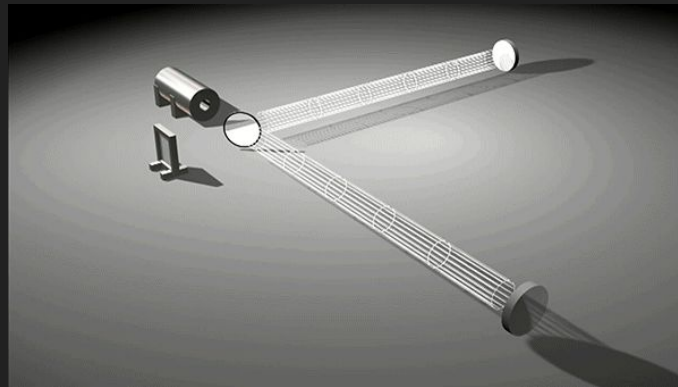
Real Life Examples

- Sound is able to move due to the vibrations of noise causing waves
- Electrons are bound to the nucleus of their atom in standing wave patterns
- When you drop a pebble into a still body of water, the ripples in the water are the same concept as any other wave
- Radio waves allow us to hear the music on whatever radio station you like
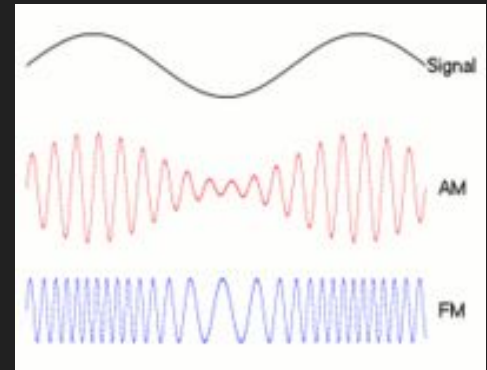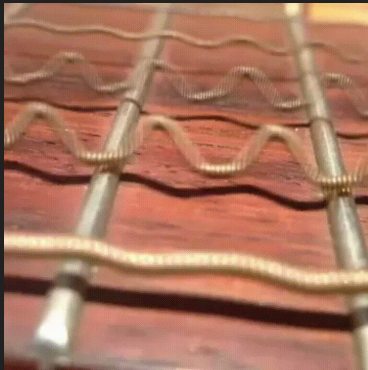
Commonly Made Mistakes

Waves carry **ENERGY**, not MATTER

Acceleration is **NOT** constant when talking about mass spring systems

DON'T confuse frequency, f, with angular frequency, $\omega = 2\pi f$

Period and Frequency of a wave do **NOT** depend on the amplitude, unless wave/motion is huge

For Hooke's Law - There is **NEVER** any friction involved

For the equation, a = -kx/m (Hooke's Law), acceleration is **NEVER** constant and you **CANNOT** use kinematics to solve